Data Display and Analysis Program
for an
Enhanced NWSRFS Calibration System

Functional Requirements and Design Considerations
Lumped Model Applications

by Eric Anderson

Introduction

This report offers suggestions for enhancing the National Weather Service River Forecast System (NWSRFS) calibration system. The report focuses on a portion of the enhanced system that will be referred to for now as the Data Display and Analysis Program (DDAP). DDAP would be designed to support the recommended conceptual model calibration process described in the August 2002 manual on Calibration of Conceptual Hydrologic Models for Use in River Forecasting by this author. The process described in the Calibration Manual is for use in applying conceptual hydrologic models in a lumped manner (i.e. using spatial averages of input data as opposed to gridded data fields and generating areal estimates of model output and simulations of river flows at distinct locations as opposed to distributed model computations). DDAP would contain the software tools needed for steps 2 through 4 (assess spatial variability, select periods of record, and data analysis), to prepare input and view results from step 5 (model calibration), and to be a source of information for step 6 (operational implementation) as described in the Calibration Manual.

Besides DDAP an enhanced NWSRFS calibration system is envisioned to contain other components. These would include:

- An expanded historical data acquisition component - would be able to access a wide variety of historical data and supporting information for utilization by the rest of the calibration system. The data provided would include measurements from all relevant U.S. , Canadian, and Mexican data collection systems, needed data fields generated by various procedures (e.g. radar based precipitation estimates, gridded snow model values, and meteorological model output), and archived operational data. The data and information required from the data acquisition component by DDAP is described in this report.

- Lumped model calibration component - would use areal averages of input along with various measurements needed to verify model performance in order to simulate historical conditions to determine parameters for a variety of hydrologic models (step 5 in the Calibration Manual). All data would be in time series form. The NWSRFS programs that perform this function are the Interactive Calibration Program (ICP), the Manual Calibration Program (MCP), and the automatic parameter Optimization program (OPT). ICP provides interactive controls and graphical displays for MCP. Suggestions for improving ICP were provided by this author in the January 2003 report Interactive Calibration Program -

Suggested Changes and Enhancements. There are probably ways to improve the usefulness of automatic parameter optimization procedures through the inclusion of recent research and new approaches into the OPT program, possibly with some interactive controls and graphical output. Suggestions for such enhancements should be provided by those who believe in such methods and are actively involved in developing and testing such procedures.

• Spatial data analysis and distributed model calibration component - would contain procedures to analyze and process spatial data fields and to determine appropriate parameters for distributed applications of hydrologic models. Included should be software to derive average areal estimates from gridded data for use in the ICP/MCP and OPT programs. Lumped modeling using areal averages obtained from spatial data fields can be useful for evaluating data issues, assisting in the determination of model parameters for distributed applications, and comparing simulation results. Requirements for this component should be provided by those who have actively been working with spatial data and the distributed application of hydrologic models.

The various components of an enhanced calibration system could possibly be tied in to a common user interface, though the creation of a single super program that does it all doesn't seem like a realistic objective. It is most important that all the components have an interface with a common "look and feel". The requirements suggested for the DDAP user interface in this report are intended to have the same general form as those for ICP. It is also important that the flow of data and information from one component to another utilizes a common data storage and retrieval structure and doesn't require any special transformations. All output from one component that is needed by another component should be readily available in the proper form.

The procedure recommended in the Calibration Manual for analyzing and processing input data, determining model parameter values, and evaluating results is based on working with a reasonably large geographical area involving many data collection stations and stream measurement sites as opposed to an individual watershed or downstream river location. Such an area may be a single river basin (e.g. the Minnesota River basin), a portion of very large basin (e.g. the Mississippi River from St. Paul to Dubuque), or a series of small basins within a common climatic regime (e.g. streams entering Puget Sound from the east). The term "Basin" is used when referring to all such areas in this report. The suggestions for the DDAP component of an enhanced calibration system in this report are based on a framework organized by river basins.

The displays, techniques, and procedures needed by the portion of the calibration process covered by DDAP vary depending on the available data, forecast requirements, and the general climatic conditions for the basin being analyzed. Thus the steps in the process cannot be provided in a cookbook fashion. The idea is to provide an interactive system of tools with graphical displays that would allow the user to view the information and perform the necessary analyses. All of the tools needed to perform these functions should be available in a single integrated environment. It is then left up to the user to select which tools are needed and the sequence of how they are applied.

Background

<u>Existing Software</u>

The current NWSRFS calibration system includes a number of individual programs that perform various functions that fall within the envisioned DDAP component. These are:

- Precipitation Preliminary Processing program (PXPP) used to determine mean monthly precipitation for all stations in a mountainous region for a specified period of record (POR),
- Mean Areal Precipitation computational program (MAP) utilizing daily and hourly gage data to generate areal averages,
- Mean Areal Temperature computational program (MAT) utilizing daily max and min temperatures to generate areal averages,
- Temperature-elevation Plot program (TAPLOT) used to determine monthly relationships between max and min temperature and elevation over a given region,
- Mean Areal Potential Evaporation computational program (MAPE) utilizing point estimates of PE to generate areal averages,
- Interactive Double Mass Analysis program (IDMA) providing graphical displays and interactive determination of consistency corrections in conjunction with the PXPP, MAP, MAT, and MAPE programs,
- Calibration Assistance Program (CAP) utilizing GIS functionality to display watershed boundaries, PRISM precipitation and temperature estimates, topography, forest cover type, soils information, and snow cover images; to allow the user to subdivide a watershed into elevation zones; to produce watershed and zonal estimates of forest cover and type; and to generate area-elevation curves, precipitation-elevation plots, and mean, max, and min values of precipitation, PE, PE adjustments based on vegetation greenness fractions, and 11 Sacramento model parameters derived from soils data, and
- Integrated Hydrologic Automated Basin Boundary System (IHABBS) which generates drainage boundaries and synthetic unit hydrographs.

Most of these programs were developed by the Office of Hydrologic Development (OHD). IHABBS was developed by the National Operational Hydrologic Remote Sensing Center (NOHRSC). While these software programs provide much of the functionality needed for the DDAP component, i.e. assessing spatial variability, selecting periods of record, analyzing historical data, and providing initial estimates of model parameters, there are three main deficiencies with the current group of programs.

1. The available tools do not constitute an integrated system with a single interactive user interface. Some of the programs have interactive, graphical interfaces though the “look and feel” varies, while others use free or fixed format input files. Also, while some of the programs produce output in the form needed by a subsequent step, there is still considerable manipulation and editing of files required.

2. A number of the analyses recommended in the Calibration Manual as part of the process

covered by DDAP must be done manually as no software tools currently exist. In many cases this results in these analyses not being done or being done in a crude, simplified manner.

3. There is no overall system for organizing the historical data analysis process and keeping track of the information generated. This can result in improper values being used at various steps in the process. In addition, multiple analyses may exist for a given area done at different times in the past, by different people, using different methods, for different periods of record, and based on different archived data. This can clearly cause problems when implementing the calibration results into the operational environment and especially when extending the historical record at a later date or just trying to determine what was previously done.

The objective of DDAP is to provide the software tools to produce the displays and perform all of the analyses needed under an interactive interface with one common "look and feel". The system needs to utilize graphical displays to the maximum extent possible to assist the user in visualizing the information and results. A method of organizing the process is needed so that one can keep track of what has been done. A data base will be required in order to store results from each tool for use during subsequent steps in the process and to maintain information for future applications of the results.

Historical Data Analysis Methodology

It is assumed that the underlying methodology of the current historical data analysis programs will remain for the most part in an enhanced calibration system. The current programs, PXPP, MAP, MAT, and MAPE utilize a computational approach involving checking the consistency of the data using a double mass analysis, estimating missing station data based on surrounding gages, and then weighting the stations to obtain areal averages. In mountainous areas ratios or differences between monthly means are used to adjust data used for estimating missing values, while in non-mountainous areas, the long term means of all stations are assumed to be the same. Station weights used to generate areal values can be based on the location of the stations or assigned by the user based on subjective criteria. Even though this general methodology for producing areal estimates will be retained in an enhanced calibration system there are several deficiencies, as mentioned in the Calibration Manual, that should be corrected.

- The calibration MAT program needs to use the same data and method as the operational MAT preprocessor function as discussed in Section 6-4 and Chapter 8 of the Calibration Manual. This means that both max/min and instantaneous temperature data need to be used during the historical analysis. Currently only max/min data are used for calibration.

- A temperature data preliminary processing capability is needed so that mean monthly max and min temperatures for the historical period of record are estimated in a consistent manner (such a program, PXPP, currently exists for precipitation). The procedure to follow is outlined in Section 6-4 of the Calibration Manual.

• A preliminary analysis program is needed for mean daily streamflow data as discussed in Section 6-6 of the Calibration Manual. This program would use a procedure similar to that in PXPP to check the consistency of streamflow measurements.

• The MAP program should allow for different definitions of the summer and winter seasons for consistency checks and corrections than are used for station weights as discussed in Section 6-3 of the Calibration Manual.

This report assumes that these changes and additions will be made prior to or as part of the development of an enhanced system. In addition, it will be necessary to make other changes to the current code as the historical data analysis programs are integrated into DDAP . Some of the current input options will no longer be relevant and certain output will be written to a data base or displayed graphically rather than in the current text form. Also, sequence numbers used in several of the programs should be eliminated so that stations are always referred to by a single identifier.

Organization

As mention previously, the recommended method for model calibration is based on working with a reasonably large geographical area, referred to as a Basin. Thus, it is recommended that DDAP should be organized around this concept. In order to be consistent with ICP and to assist in keeping track of the Basins, Regions should also be defined. A Region is made up of several Basins (an RFC area could be divided into several Regions or all lumped into one Region depending on the preference of each office). For drainage areas within a Basin, the term Watershed will be used in this report. A Watershed can be a headwater drainage or a local area. Watersheds can overlap (e.g. a Watershed could be defined for the entire drainage above a river location or just the local area between that location and one or more upstream points). Basins could also overlap since a new calibration effort may not use the same breakdown of an RFC area as was used previously. For the types of data that are used as input to drive snow and land phase models, a particular period of record is associated with a given analysis. Station and areal means, as well as spatial data variations such as those defined by an isohyetal map, are tied to a specific period of record. Extensions to the record rely on values based on the period of record used for the initial analysis. This is the case for precipitation, temperature, and evaporation. Different analyses could exist for these data types for the same basin using different periods of record. There is a need to keep track of all such analyses until the results are deemed to be no longer needed.

To summarize, the proposed organizational entities for DDAP are:

• Basin - a drainage area covering a reasonably large geographical area typically within a single climatic regime (as mentioned under the introduction to this report, a Basin could be the drainage area above a single river location, a portion of a large river system, or a combination of several relatively small, adjacent drainages),

- Region - a combination of several Basins,

- Watershed - a headwater or local drainage area within a basin (Watersheds can be subdivided by elevation, travel time, or other physiographic factors), and

- Precipitation, Evaporation, and Temperature Analysis (PETA) - an analysis of precipitation, evaporation, and/or temperature data with possible extensions that is based on a particular historical period of record (HPOR) - a PETA is not a physical entity.

There will be issues involving discrepancies and discontinuities between information for adjacent or overlapping basins. Similar problems could exist between different analyses for the same basin. Examples include discrepancies in mean monthly values and consistency corrections for stations utilized by multiple basins and different analyses and discontinuities in adjusted isohyetal analyses at boundaries. In some cases these may be due to differences in the periods of record used, but they may also be caused by variations in the information selected for analyzing each basin or by having different personal performing each analysis. These issues will be discussed in more detail in various sections of the report.

Design Considerations

This report provides suggestions for the functionality of DDAP. It is not intended as a software design document. There are a number of items that are mentioned in this report that will have to be defined in more detail and expanded before the software can be written. A listing of some of these items and a few related general suggestions that might be helpful to those producing the software are provided.

- Data Base - The majority of the information produced as one goes through a calibration needs to be saved so that it can be used by a subsequent step in the process. Much of this information is also needed when implementing the calibration results into the operational environment, when extending the historical period of record, and for future reference as to how things were done. It seems like in order to have this information readily available and easy to reference, a data base is needed. The actual time series of historical data could be maintained in flat files, as is currently the case, with the file location stored in the data base. Also the location of files containing text output from some of the components could be similarly maintained. However, the other information should be stored directly in the data base. As the various tools needed for DDAP are described in this report, there will be a listing of the information that needs to be provided and that which should be saved for subsequent use. Whenever relevant, the information generated by DDAP that is stored in the data base should include a tie to the associated Basin and PETA.

- User Interface and Displays - As mentioned previously the enhanced calibration system needs to have a common “look and feel”. This means that the type of user interface and the form of the displays should be similar for each component of the system. Suggestions will be offered for the general contents of the main DDAP control windows, however, it is left up to the designers to determine exactly how the items that control overlays, zooming, queries, analysis tools, and displays are arranged within the windows. It is strongly suggested that the interface be designed in a manner that should be easy to operate for all potential users. If the user understands the steps to follow when doing a calibration and the procedures that are to be used, very little training should be needed in order to use the enhanced system. An understanding of a particular GIS interface or data base language should not be required in order to use the system, though a system administrator may need such knowledge in order to initiate and maintain the software.

• Data Sets - It is not the intention of this report to specify the exact data sources that need to be available for DDAP. This includes both hydrologic data collected by different agencies at various locations and available in time series form and raster or vector data sets of spatial information. The report will indicate the historical information that needs to be provided by the data acquisition component of an enhanced system without indicating all the potential sources of such data and the procedures needed to put it into the form needed for further processing. The report will also indicate the types of raster and vector data needed for displays and overlays without specifying the exact data sets should be included. It will be left up to the software designers, with input from people that are very knowledgeable about data of various types, to determine which data sets are used. In general DDAP should rely on nationally available spatial data sets, although this should not preclude the use of more accurate data sets that may be available and needed for particular areas.

• Naming Convention - Identifiers will need to be assigned for stations, Regions, Basins, Watersheds, zones, time series, PETAs, etc. in order to keep track of all the information needed for calibration. It is recommended that a naming convention be established to provide default identifiers for most of these entities so that there is consistency across not only DDAP, but the entire calibration system. The root of the naming convention could be the NWS Handbook 5 identifiers used for stations operationally, though some historical stations would not have official NWS HB5 identifiers. Identifiers for Watersheds would be based on the station at the outlet, zone identifiers would be based on Watershed identifiers with a subscript (such as 'H' for high elevation, 'M' for mid level, and 'L' for low elevation), time series identifiers would be based on the station, Watershed, zone, etc. to which they are associated. A general system could be established with the option for each RFC to have some control as to how identifiers and subscripts were assigned.

• If an enhanced calibration system becomes a reality, ICP/MCP should be further modified (beyond the suggestions in the January 2003 report) to interface with DDAP and the other components of the enhanced system (OPT would also need to be made compatible with the enhanced system). This would require that ICP/MCP utilize the data base that would be part of an enhanced system to read, store, and update information and incorporate the system wide naming convention. In addition, since the way a river basin is broken down into individual drainages, the period of record used, the historical data analysis, and how the calibration is performed could vary from one calibration effort to another, the resulting parameter values are also likely to vary. Thus, the model calibration programs in an enhanced system should include the specification of a PETA that would be associated with the parameter sets for each calibration effort.

• Utility Functions - Besides the tools described in this report, there will be a need for certain utility functions not only for DDAP, but for the entire calibration system. Utility features need to be provided to display time series and other observed and generated data values, as well as other information stored in the data base such as parametric data, meta data, graphical relationships, etc.. There is probably also a need to provide the capability to edit certain records, especially time series, beyond what is mentioned in this report. Some of these utility functions could possibly be incorporated into query or display capabilities or a utilities menu with various options could be added to some of the windows.

• The description in this report of most of the tools envisioned for DDAP cover the functionality when a particular analysis or computational procedure is first run, though in some cases the report discusses re-running the tool to revise results. The capability to re-run an analysis should be included in all the tools when appropriate. When a tool is re-run for a particular Basin, PETA, period of record, or Watershed, typically the information used on the prior run should be the default for a subsequent application. The user should then be able to change values as needed.

Historical Data Acquisition

The data acquisition component for the enhanced calibration system is expected to provide to DDAP as much of the archived data as possible for all of the types listed in the Historical Data Requirements section of Chapter 3 of the Calibration Manual. This includes precipitation, temperature (both max/min and instantaneous), evaporation, streamflow, reservoir and lake, and snow data. Most of these data will be based on measurements at a particular location though some could be averages over an area (e.g. aerial gamma flight line data and percent areal snow cover). In addition to the actual variables, meta data for all measurement sites is required. The meta data should be stored in a data base for use by DDAP and possibly other components of the enhanced calibration system. The meta data should include:

- Site identifier (should be unique - typically Handbook 5 ID)
- Site name
- Collection agency and identifier used by that agency
- Site location (most recent location)
- Site elevation (most recent location)
- Drainage area - if appropriate (most recent location)
- Data types - for each include:
    - Time interval of data,
    - Observation time (if relevant - most recent),
    - Source code (direct measurement, computed, adjusted, etc.),
    - Equipment used (direct measurement),
    - Method (computed, adjusted),

    - Period of record,
    - Prior observation times and dates,
    - Prior equipment or method and dates,
    - Completeness of record (monthly - calculated from time series), and
    - Mean or totals for each month (computed from observed time series - for means, the number of values should be retained; for totals, indicate missing if any values are missing during the month).
- Prior site location, elevation, and drainage area history
- Remarks (either from collection agency or supplied by user)

The meta data should always be provided when a measurement site is added to the data base for the enhanced calibration system. Hopefully much of the meta data can be obtained from digital records, however, some may have to enter manually from printed records. The meta data should always be updated when the record for a site is extended. DDAP will not know that measurements are available and will not be able to utilize data from a given site until the meta data record is complete. The form of meta data for areal average values will likely be somewhat different than for a point location.

Most actual observations will be in time series form with a reporting interval of 24 hours or less. However, there may be some data of value for longer intervals such as monthly diversion volumes. Though infrequent measurements, such as manual snow course measurements or flight line data, could be stored in time series form, they could also be stored as time, value entities and then expanded into a time series when read by DDAP or other calibration programs. Completeness of record and monthly averages or totals could be computed as needed, but to save time it would most likely be best to compute these quantities when the data are added into the system and store the results.

Most of the historical data will be obtained from digital records. The data will be retrieved either directly by accessing the collecting agency's Internet site or from the NOAA Hydrologic Data System (NHDS). Some of the data in the NHDS are obtained from another agency and reprocessed for easy retrieval and to check the quality of the records. The NHDS also contains archived operational data that would be useful for calibration. However, some historical data needed for calibration may only be in printed form, thus the data acquisition component should allow for the manual entry of data.

Functional Requirements for DDAP

<u>Introduction</u>

It is envisioned that the user interface for DDAP will utilize two primary control windows. The first will be an initialization window used to define and modify Basins and Regions, Select a Basin for analysis, and Delete a PETA, Basin, or Region. The second will be the main control window for a Basin analysis. It will allow the user to define a PETA and use the display and analysis tools provided to produce the time series and generate the information required for the portion of the calibration process covered by DDAP. It will include overlay, zoom, and query capabilities in addition to providing access to various displays and analysis tools.

Program Initialization Window

When DDAP is initiated it is envisioned that the first window to appear will be used to chose the basin to be worked on. The functions in this window will also need to include the selection of a region, the definition of basins and regions, and the ability to delete regions, basins, and PETAs. This window should contain Control and Delete menus with various options.

Control Menu

- New Region
  Function: Define a new Region
  User Input:
    - Identifier, and
    - Description.
  Remarks:
    - Just an entity to assist in keeping track and organizing the calibration information over an RFC area, and
    - No location or boundary values required.

- New Basin
  Function: Define a new Basin
  User Input:
    - Identifier,
    - Description,
    - Number of outlet locations,
    - Specification of outlet locations - either by specifying the identifier of river measurement sites or the latitude and longitude at the outlet points,
    - Number of upstream inflow points for each drainage and a specification of the location of each,
    - Latitude, longitude box that completely surrounds the basin drainage, and
    - Region to which the basin belongs - region identifier.
  Remarks:
    - The boundary tool (described in Appendix B) should be invoked to determine the drainage boundary above each outlet location and downstream from any inflow points (link to each boundary should be stored),
    - Boundaries for outlet locations shouldn't overlap or be inside each another, and
    - All boundary points should fall within the latitude, longitude box specified.

- Modify Basin

<u>Function:</u> Make changes to a Basin definition
<u>Description:</u>
- User chooses from a list of existing Regions,
- User selects an existing Basin within that Region, and
- User makes Basin selection.

<u>Changes Allowed:</u>
- Region to which the Basin is assigned,
- Description,
- Add an outlet location, and
- Expand the latitude, longitude box that surrounds the basin drainage.

<u>Remarks:</u>
- All boundary points for the new drainage must fall within the latitude, longitude box specified for the Basin, and
- The boundary for the new outlet shouldn't overlap or be within an existing drainage.

• Select Basin
<u>Function:</u> Select a Basin for analysis or to extend the historical record
<u>Description:</u>
- User chooses from a list of existing Regions,
- User selects an existing Basin within that Region,
- User makes Basin selection, and
- Main Basin display window appears (described under Basin Control Window).

• Exit
<u>Function:</u> Exit the program
<u>Remarks:</u>
- All temporary files that were generated during the session should be deleted, and
- User should have to Quit all windows for the current Basin prior to exiting the program.

<u>Delete Menu</u> - This should probably be a system administer task that requires a password to invoke.

• Region
<u>Function:</u> Delete Regions that are no longer needed
<u>Description:</u>
- User chooses from a list of existing Regions

<u>Remarks:</u>
- Region can only be deleted if no Basins are assigned to the Region

• Basin
<u>Function:</u> Delete Basins that are no longer needed
<u>Description:</u>

◦ User chooses from a list of existing Regions,
◦ User selects an existing Basin within that Region, and
◦ User makes Basin selection.

Remarks:

◦ A Basin can only be deleted if there are no PETAs associated with the Basin, and
◦ Basin should be removed from the associated Region list.

• PETA

Function: Deletes a PETA that is no longer needed

Description:

◦ User chooses from a list of existing Regions,
◦ User selects an existing Basin within that Region, and
◦ User makes Basin selection and list of the PETAs for the Basin appears,
◦ User makes PETA selection, and
◦ Window appears with warning of the effect of deleting a PETA and asking the user to verify that this is to be done.

Remarks:

◦ Deletes all information that was generated by DDAP for the PETA, and
◦ Should only be done when a new PETA that covers the Basin has been completed, implemented operationally, and proven to meet all requirements.

Basin Control Window

This window will be used to define and modify information for PETAs that are associated with a Basin, Select displays to be generated, and to choose among various categories of analysis tools. The displays and analyses will take place in other windows that will appear when a display or analysis tool is chosen. This window is envisioned to contain the following:

• A display of the latitude, longitude box that surrounds the Basin with the drainage boundary for the Basin plotted and the outlet points shown (as mentioned previously a Basin definition can include one or more drainage areas),

• A listing of overlays that can be added or removed from the basin plot (discussed further in a subsequent section),

• The capability to zoom in or out (various overlays and displays would likely show more details as the area displayed is reduced),

• A query capability to display basic information regarding stations and watersheds (e.g. when the query function is on, placing the mouse pointer over the entity could display summary information and clicking could produce a window that will provide the user with options to display other available information and allow for editing of time series - details described in a subsequent section),

- Units selection for all information displayed (English or metric), and

- Menus that specify the DDAP Basin options available to the user.

The other windows that are produced when the various display and analysis tool categories are selected should contain the same overlay, zoom, query, and units options as the main Basin control window.

Overlays

The exact overlays that should be included with the DDAP Basin windows will depend on the data sets that are available. Any or all of the overlays should be able to be displayed at any one time thus, they will need to color coded (possibly including a legend) so that the user can identify one object from another. Overlays that should be considered include:

- Rivers and streams,
- Reservoirs and lakes,
- Topography (most likely using contour lines - option to highlight a particular contour could be very helpful in conjunction with several of the DDAP tools),
- Political boundaries (countries, states, counties, etc.),
- Cities and towns,
- Roads and railroads,
- Glaciers,
- Historical data sites (sites with meta data stored in the enhanced calibration data base - user should have the option to show all sites with a symbol to indicate which data are available at each or to show only those sites that have a particular type of data; either precipitation, temperature, evaporation, streamflow, or snow data),
- Operational stations (obtained by accessing operational data bases), and
- Watershed drainage boundaries (for the currently invoked PETA).

Queries

When the query option is turned on, the user will be able to obtain various information about stations and other measurement sites. The information shown would vary depending on whether a station is part of the historical network or the operational network. In addition, when a PETA has been invoked, the user would be able to obtain information about the watersheds that are part of the analysis. Some basic information should be displayed when, for example, the mouse pointer is placed over a station or watershed. Then when the user chooses a particular entity, a window could appear that offers further choices.

- Historical Network Station Query
  - Basic Information

· Identifier,
· Description,
· Elevation,
· Drainage area (if a river site),
· Data types available and reporting time interval for each, and
· Period of record for each type (can span gaps of missing values).

◦ Additional choices

· Show completeness of record for a selected data type,
· Show monthly data summary for a selected data type (include averages or totals for each month and the mean for each month over the POR),
· Show reporting information, and
  · observation times and changes for daily reported data,
  · location and history of moves,
  · equipment and changes or method of computing,
  · collecting agency and agency identifier, and
  · remarks.
· Display actual time series data and allow for editing of values.

• Operational Network Station Query

◦ Basic Information

· Identifier,
· Description,
· Location and elevation,
· Data types available and reporting interval, and
· Collecting agency, equipment or method, and remarks (if available).

◦ Additional choices (none)

• Watershed Query

◦ Basic Information

· Boundary identifier,
· Description,
· Existing areal time series that apply to the entire Watershed and POR for each,
· Number of elevation or travel time zones, and
· For each zone
  · Identifier,
  · Elevation range or river location (travel time zone), and
  · Existing areal time series for the zone and POR for each.

◦ Additional choices

· Show summary of data for a selected areal time series (include value for each month (average for MAT - total for precipitation and evaporation), average over the POR for each month, value for each water year, annual average for all years, and average seasonal values for all years if seasons defined), and
· Show actual data values for a selected time series and allow editing.

Menus

The main Basin window is envisioned to have 3 menus.

◦ Control menu - allows for the definition and modification of PETAs associated with the Basin and a Quit option,
◦ Display menu - contains options for displaying information for the Basin, and
◦ Tools menu - lists the analysis categories that user can choose from.

Control Menu

The Control menu for a Basin would need to contain the following options:

• Define PETA
  Function: Define a new Precipitation, Temperature, and Evaporation Analysis
  User Input:
    ◦ Identifier,
    ◦ Description,
    ◦ Historical Period of Record (HPOR), and
    ◦ Comments.
  Remarks:
    ◦ Once a PETA is defined, the HPOR can't be changed without deleting the PETA and defining a new PETA, and
    ◦ Combination of ID and HPOR should be unique for a given Basin.

• Modify PETA
  Function: Allows user to change description or add comments and to add extensions to the HPOR.
  Description:
    ◦ User chooses from a list of all PETAs for the Basin (ID and HPOR shown for each), and
    ◦ User indicates if an extension period is to be added to the PETA (if no, only the description can be changed and comments added or modified - if yes, in addition a new extension period is added to the PETA definition).
  User Input:
    ◦ New description and/or additions and modifications to the comments, and
    ◦ Extension period (beginning and end).
  Remarks:
    ◦ The extension period must immediately follow the HPOR or the latest extension period, and
    ◦ PETA ID and HPOR can't be changed.
• Quit Basin
  Function: Closes the Basin Control Window
  Remarks:

◦ User must have closed (Quit) all tool category windows that were opened during the session for the Basin prior to quitting the Basin, and
◦ All display windows that are currently open should be closed.

Display Menu

The Display menu for the DDAP Basin display is envisioned to include all the spatial data sets that can be shown for the Basin. When a display is chosen, a new window will appear that includes the information selected as well as overlay, zoom, query, and units options. The user can have multiple basin display windows open on the screen at any given time so that various spatial data sets can be compared. The exact spatial displays that the user can choose from will depend on the data sets that are available and included for use by DDAP. Displays that should be considered include:

- Average spatial data variability
    - Precipitation
        - Base isohyetal maps (most likely PRISM maps - user selects annual, season (winter or summer), or month),
        - Adjusted isohyetal map - could have a choice of 2 adjusted analyses - see Appendices C and D (only valid if a Precipitation category under the tools menu is currently active and thus a PETA has been selected - user selects annual, season, or month), and
        - Difference between adjusted and base isohyetal map (again only if a PETA is currently invoked - annual, season, or month - shown as a ratio or difference).
    - Temperature
        - Mean average, maximum, or minimum temperatures on a monthly basis (most likely using PRISM values).
    - Evaporation
        - Mean free water surface evaporation on an annual or May-October basis using digitized NOAA Technical Report #33 maps,
        - Average May-October pan evaporation from TR #33, and
        - Pan coefficients from TR #33.

- Soils information
    - General soil types,
    - Variation in permeability, and
    - Depth of soil layers.

- Vegetation information
    - Type of vegetation, and
    - Mean NDVI greenness fractions (monthly).

- Model Parameters
    - Sacramento model

· Gridded variation of selected parameters derived from soils data,
· Watershed or zonal averages of selection parameters derived from soils data (requires tha a PETA is selected), and
· Calibrated parameter values (apply to a Watershed or a zone).*

◦ Snow model
· Calibrated parameter values (apply to a Watershed or a zone).*

* Note: The display of calibrated parameter values will require that:
1. ICP/MCP and OPT are integrated into the enhanced calibration system and thus parameter sets are output to a data base, and
2. A PETA is specified since parameter values and the breakdown of a Basin into Watersheds will vary from one PETA to another.

Tools Menu

The Tools menu allows the user to select among the various categories of procedures and techniques that available for comparing, analyzing, and processing the data for the Basin. When a category is selected, a new window should be opened that contains a menu with the analysis tools available for that category (a Help feature could also be provided for each category that explained the methodology behind each tool and things the user should consider). Most of the categories will require that the user indicates the PETA that is to be worked on and whether the HPOR or an extension is to be analyzed. The basic information displayed and the specific analysis tools available in each category are described in separate appendices.

The suggested tool categories are:

• Streamflow - includes tools to compare streamflows at various locations within the Basin, compute local area contributions, make adjustments to streamflow data, prorate monthly volumes into daily flows, and preform consistency checks (doesn't require that a PETA is selected - described in Appendix A)

• Watersheds - includes tools to define and modify watershed boundaries, specify the subdivision of watersheds by elevation or other means, and to determine basic watershed properties (PETA must be chosen - described in Appendix B)

• Precipitation - requires that a PETA and either the HPOR or an extension be selected. The precipitation tools should be divided into 2 categories:

◦ Spatial Analysis - includes tools to select stations, perform consistency checks, compute monthly means, analyze spatial variations, adjust spatial analyses to conform to the observations and period of record, and produce information for subjectively assigning station weights (described in Appendix C), and

◦ Areal Time Series - includes tools to compute mean areal time series, plus tools to assist in determining area means utilizing water balance computations (described in Appendix D).

• Temperature - requires that a PETA and either the HPOR or an extension be selected. The temperature tools should be divided into 2 categories:

◦ Spatial Analysis - includes tools to select stations, preform consistency checks, compute monthly means, and determine elevation variations (described in Appendix E), and

◦ Areal Time Series - includes tools to compute mean areal time series (described in Appendix F)

• Evaporation - requires that a PETA and either the HPOR or an extension be selected. Includes tools to compute daily Potential Evaporation (PE), estimate seasonal PE adjustment curves, and determine average ET-Demand estimates (described in Appendix G).

• Model Parameters - includes tools to derive initial parameter estimates for selected hydrologic models (described in Appendix H).

The selection of which tools to use within a given category would be up to the user though some tools depend on information generated by another tool. In these cases the user should be informed that all the needed information was not yet available and indicate which tools would provide the needed values.